Bone Repair
and Biomedical Engineering
Repairing Bones: Overview

• Some serious breaks need the aid of engineers because:
  – Need to restore function and position
  – Likely not to heal correctly
  – High risk of infection
  – Very long healing time

• Biomedical engineers use internal and external fixation approaches

• While beneficial, added challenges and possible complications exist
Internal vs. External Fixation

• **Internal fixation:**
  Temporary or permanent fixtures directly attached to the bone **under the skin**, for alignment and support
  – pins
  – rods or nails
  – plates
  – screws
  – wires
  – grafting

• **External fixation:**
  Temporary repair supports **outside of the skin** that stabilize and align bone while the body heals
  – screws in bone to hold in place
  – metal braces or casts
  – can be externally adjusted
Internal Fixation

To determine the best repair technique, the break type and location are considered.

External Fixation

Installing temporary repair supports outside of the skin to stabilize and align bone while the body heals.

**Examples:** screws in bone, metal braces, casts, slings.

Example

Spiral fracture-torsion break

Tibia and fibula broken while skiing and repaired with a rod and pins.

*Image source:* Art's Spiral Fracture Pix, University of Arizona.,
[http://dingo.sbs.arizona.edu/~hharley/skilegtext.html](http://dingo.sbs.arizona.edu/~hharley/skilegtext.html) Used with permission.
Example: Rods, Plates and Screws

- **Rods** are used for alignment and support of long and large bones
- **Plates** hold together loose pieces of bone and support smaller bones
- **Screws** hold plates and rods in place

Example: Rods, Screws and Pins

Pins are similar to screws and usually affix a detached piece of bone.

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More Plates and Screws

X-ray example of shattered dog femur that was repaired with a plate and seven screws.

Bone Grafting Example

Graft material is removed from patient’s ilium (pelvis, hip) [left]

Bone graft fills a gap in a human spine [right]

Medical Implant Materials

• Bone is an amazing material: strong and flexible
• Most human-made materials that are strong are also brittle
• To be accepted by the body and not cause other problems, the materials for rods, pins, screws and plates must also be biocompatible.
• Engineers design materials especially for medical implants that are made of:
  – Surgical stainless steels (blends of nickel, chrome and molybdenum)
  – Titanium alloys
  – Polymers
Results

After a few months, patients should be back on their feet, ready to participate in everyday activities.